OPTICAL SYSTEM AND IMAGING APPARATUS INCLUDING THE SAME

BACKGROUND

Field of the Disclosure

[0001] The present disclosure relates to an optical system and an imaging apparatus including the optical system, and for example, is suitable for an imaging apparatus using an image sensor, such as a digital still camera, a video camera, a monitoring camera, or a broadcasting camera, or suitable for an imaging apparatus such as a camera using a silver halide photographic film.

Description of the Related Art

[0002] As an imaging optical system having a long focal length, a so-called telephoto-type imaging optical system is known, in which an optical system having positive refractive power is placed on an object side, and an optical system having negative refractive power is placed on an image side. The telephoto-type imaging optical system is used for a single-focus ultra-telephoto lens, for example.

[0003] In an ultra-telephoto lens, generally, the longer the focal length, the more axial chromatic aberration or magnification chromatic aberration occurs. As a technique for excellently correcting these types of chromatic aberration, a technique for increasing the number of lenses placed on an object side and causing the lenses to share the action of correcting chromatic aberration is known. However, the effective diameter of a lens placed on the object side of the ultra-telephoto lens is likely to be large. Thus, if an attempt is made to correct chromatic aberration by the above technique, the weight of an imaging optical system increases.

[0004] In an imaging optical system discussed in Japanese Patent Application Laid-Open No. 2015-215561, positive lenses formed of a material having low dispersion and anomalous dispersion are placed successively from furthest on an object side, thereby correcting axial chromatic aberration and magnification chromatic aberration.

SUMMARY OF THE INVENTION

[0005] The present invention is directed to providing an optical system which is small and in which aberration such as chromatic aberration is excellently corrected, and an imaging apparatus including the optical system.

[0006] According to an aspect of the present invention, an optical system includes a first lens unit having a positive refractive power, a second lens unit, and a third lens unit disposed in order from an object side to an image side, the second lens unit configured to move in focusing so that an interval between adjacent lens units among the first, second, and third lens units changes, wherein the first lens unit includes a positive lens G1*p* disposed closest to the object side and a negative lens G1*n* being a closest negative lens with respect to the object side, and wherein the following conditional expressions are satisfied:

$$0.02<BF/fG1p<0.14$$

$$2.00<|fG1p/fG1n|<10.00$$

$$20.0<vdG1n<40.0$$

$$-0.1000<\theta gFG1n-(-1.665\times10^{-7}\times vdG1n^{3}+5.213\times10^{-5}\times vdG1n^{2}-5.656\times10^{-3}\times vdG1n+0.7268)<-0.0010$$

where BF is a back focus of the optical system, fG1*p* is a focal length of the positive lens G1*p*, fG1*n* is a focal length of the negative lens G1*n*, vdG1*n* is an Abbe number of a material of the negative lens G1*n*, and θgFG1*n* is a partial dispersion ratio of the negative lens G1*n*.

[0007] Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a lens cross-sectional view of an optical system according to a first exemplary embodiment.

[0009] FIG. **2** is aberration diagrams of the optical system according to the first exemplary embodiment when the optical system focuses on infinity.

[0010] FIG. **3** is a lens cross-sectional view of an optical system according to a second exemplary embodiment.

[0011] FIG. **4** is aberration diagrams of the optical system according to the second exemplary embodiment when the optical system focuses on infinity.

[0012] FIG. **5** is a lens cross-sectional view of an optical system according to a third exemplary embodiment.

[0013] FIG. **6** is aberration diagrams of the optical system according to the third exemplary embodiment when the optical system focuses on infinity.

[0014] FIG. **7** is a schematic diagram of a main part of an imaging apparatus.

DESCRIPTION OF THE EMBODIMENTS

[0015] Based on the attached drawings, exemplary embodiments of an optical system and an imaging apparatus including the optical system according to the present invention will be described in detail below. The optical system according to each exemplary embodiment includes a first lens unit having positive refractive power, a second lens unit, and a third lens unit placed in order from an object side to an image side. The second lens unit moves in focusing, so that the interval between adjacent lens units among the lens units changes. A "lens unit" is a lens element that moves in an integrated manner in focusing. The "lens unit" may only need to include one or more lenses, and may not need to include a plurality of lenses.

[0016] FIGS. **1**, **3**, and **5** are cross-sectional views of optical systems according to first to third exemplary embodiments, respectively. The optical system according to each exemplary embodiment is an imaging lens system for use in an imaging apparatus such as a video camera, a digital camera, a silver halide film camera, or a television camera. In each lens cross-sectional view, the left is an object side (the front), and the right is an image side (the rear). Further, in the lens cross-sectional view, when j represents the order of lens units from the object side to the image side, Bj indicates a j-th lens unit.

[0017] In each exemplary embodiment, the cross-sectional view illustrates an aperture stop SP. In the optical system according to each exemplary embodiment, the aperture stop SP is placed between a first lens unit B**1** and a second lens unit B**2**.

[0018] The cross-sectional view illustrates an image plane IP. When the optical system is used as an imaging optical